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ABSTRACT

These three colloqium papers focus on math readiness and the young child, the use of games in teaching basic math skills, and the teaching of math concepts through informal day care activities. The first paper discusses notions about math readiness. It points out that mental age has little to do with readiness to learn basic concept skills and that it is now widely accepted that infants as young as 6 to 8 months of age recognize and operate on basic math principles. Educators in the Froebel tradition recognized this fact and incorporated two of Froebel's basic tenets as the foundation of discovery learning activities. These tenets state that: (1) young children learn best through play, where motivation is high and curiosity prevails, and (2) young children need a predominance of first-hand experiences with concrete, three dimensional materials which allow them to explore, experiment and transform materials. The second paper provides guidelines for the selection and use of games involving basic math skills for young children, and explains procedures of adding, subtracting, multiplying and dividing with Cuisenaire rods. The third paper describes the background, classroom structure, and classroom activities of the Hilltop Child Development Center at the University of Kansas. Math concepts introduced to various age groups at the center are also discussed. (Author/SS)

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EARLY MATH EXPERIENCES AND THE FACILITATIVE ADULT

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MATH READINESS AND THE YOUNG CHILD

K. EILEEN ALLEN

When is a young child ready to learn math? There is no "right" answer to this question, as we all know. Children vary so much, one from another, in terms of their interests and capabilities, their experiences and backgrounds. In groups of normally developing children, I have known 2 1/2 year olds who could deal competently and gleefully with one-to-one correspondence tasks up to five or six items; and within that same group, 4 1/2 or 5 year olds who could scarcely cope at all with such tasks. What makes the difference?

Educators and child psychologists used to explain the difference in terms of mental age (MA) - the five year olds mentioned above were not "ready". Nowadays we are convinced that MA has little or nothing to do with the readiness to learn basic concept skills of any kind. The MA criterion for readiness for academic-type learning has had a long and powerful hold, however. It sprang up during the heyday of intelligence testing with the resulting IQ scores. Many educators became enamored of this notion of mental maturity as a measure of readiness and the concept was widely accepted for a number of years as an index of when to start teaching what. In the 30's, for example, Washburne (1939), discussing the then current research on grade placement wrote, "This much, at least, can be said with certainty: "Multiplication tasks should not be taught below the

mental age of 8 years, 4 months." With such hyperbole, delay became the rallying point for the child developmentalists and educators; a "Doctrine of Postponement" became the order of the day.

Even in those days, serious doubts about these concepts were being expressed, however. Authur Gates, a highly respected reading researcher of that era, said that statements concerning the necessary mental age at which a child could be intrusted to learn to read were essentially meaningless; and Brownell, another eminent researcher, in his subsequent efforts to combat the Doctrine of Postponement reminded his fellow educators (most facetiously) that very young children in the British infant schools were learning arithmetic which we in America know young children cannot learn (Brownell, 1969). Unfortunately, old myths neither die nor fade away and there are, even today, individual educators, even entire school districts, that subscribe to the notion of a child measuring up to a prescribed MA before he or she is taught certain academic-type skills. This, in spite of the fact that there have been extensive demonstrations to the contrary that a criterion of MA alone is not valid.

Where does all of this leave us in terms of the original question that was posed, "When is the young child ready to learn math?" A logical answer, in terms of current thinking, is that the young child is always ready. Perhaps that is too

pat an answer but it does derive from very convincing evidence coming out of the infant and young child research of the last two or three decades. This is the evidence indicating that even very young infants can and do make a variety of complex, discriminative responses. In other words, they can sort out visual stimuli, auditory stimuli, and even tactual stimuli; they can respond differentially to human faces, to human voices, and to other significant environmental events.

Piaget was probably one of the first to document these very early percursors to cognitive "reasoning" patterns while observing his own infants in their cribs. Modern day researchers have since accumulated a vast collection of research studies documenting exceedingly complex discriminations that infants as young as 3 and 4 weeks of age are capable of sorting out (Horowitz, 1974).

By 6 to 8 months of age, of course, there is no doubt that many infants are "into" recognizing and operating upon basic math principles. Let me give an example:

> I am the self-appointed grandmother of the 7 1/2 month old infant son of a pair of my favorite graduate students in our department; thus, surrogate "grandson" visits my office frequently, and I get to hold him while mother or father and I talk about dissertations and data points, or whatever. Last week as I was holding him, he reached up and grabbed at the earring on my left ear. I reached back, took it out of his hand and

went right on talking, without so much as turning my head to look at him. Immediately he began squirming and thrashing about until he got in a position to grab the other earring. Obviously, somewhere in his sensory motor awareness was the concept of "pairs" and of "one-to-one correspondence" - ears come in pairs; ergo, if ear one sports and earring, ear two must be likewise endowed.

It was observations like these, documented a thousand times over in naturalistic environments and in controlled experimental settings, that led noted child developmentalists to do a complete about-face as to what very young children can learn. Among these noted developmentalist who were so instrumental in spearheading this about-face was Jerome Bruner who declared that the traditional notion of readiness was a "mischievious half-truth" - that readiness must be taught and that opportunities for its nurture must be provided instead of sitting around waiting for it to appear. On the heels of such assertions came his now famous declaration that any subject could be taught to any child at any age in some intellectually honest form. It was also Bruner who asserted that "Knowing is a process, not a product." (Bruner, 1968).

I believe that the very early educators of young children, a hundred and more years earlier, grasped such truths almost intuitively. Frederich Froebel, often called the "inventor"

or father of the kindergarten is perhaps the best example of all. In the early and mid 1800's he provided very young children with literally hundreds of different math activities grouped into what he called "gifts" and "occupations". These young children not only learned the basic arithmetic and geometric principles but delighted in the learning process itself!

Part of Froebel's historic hallowedness, where most of us 20th Century early childhood people are concerned, is that he was probably the first to formulate the theory of playful activity as being the young child's most powerful mode of learning, regardless of the subject matter area. (Leeb-Lundburg, 1970). Froebel was also the first to create and use almost exclusively concrete, manipulatable, structured materials in providing math experiences for young children. It was he who set a precedent for subsequent innovators like Maria Montessori, and more recently George Cuisenaire, to name but two. The rise and fall of Froebelian movement in Germany (and Europe) as well as here in the United States, is too intricate to review here. (The interested reader is referred to a lively paper by Leeb-Lundburg (1970) for a comprehensive overview.) For our purposes it is enough to say that many, or at least two, of his basic tenets continue to prevail: 1) young children learn best through play, where motivation is high and curiosity prevails; and 2) young children need a predominance of first-hand experiences with concrete, three dimensional materials that allow

them to explore, experiment and transform materials -- in other words to learn through "discovery". Certainly "Discovery Learning" has come to be a basic principle underlying many modern early childhood curricula, especially those that are derived from a cognitive model.

Let us look for a moment at "discovery learning" as it relates to programs for young children. Learning through discovery is in a way, a circular process - it favors the well-prepared mind (Bruner, 1968) and in young children a well-prepared mind is, in turn, dependent upon a well-prepared environment. In other words, in discovery learning the greater the freedom given to the children and the more open the learning environment, the greater is the need for teacher planning (Scott and Garner, 1978). In addition, if discovery learning is to be most effective, teachers of young children (actually all children) should also practice what has been called "the canny art of intellectual temptation." Teachers can do this not only in the way they arrange the learning environment but also in the ways in which they respond to children's questions, comments, observations and requests for information. Thus, instead of giving a child the "right" answer and so closing off that child's inherent urge to gain understanding, the teacher leads the child into further investigation at both the verbal and manipulative level. For example, picture a child stuck on duplicating a red square in a parquetry design: the teacher may just touch, ever so

tentatively, two red triangles. Often that is all it takes for the child's "aha!", the insight that leads the child to achieve the final solution of the problem independently. And what a glorious experience that is for the child as is so evident in the child's glow of satisfaction and joyful voicing of success, "I did it all by myself!"

The parquetry problem mentioned above, that of replicating a pattern, is an example of one of the many basic math properties inherent in the common every preschool materials found in most of our classrooms. As Joan Reiber and Moe Goetz make their presentations, you will note innumerable examples of manipulative materials and a variety of concrete experiences that encourage children to learn basic math principles such as:

patterning
likenesses and differences
classification
seriation
one-to-one correspondence
sets and attributes
spatial relationships
number recognition
rote counting
math vocabulary

And now it is my pleasure to introduce Joan Reiber who will talk about math experiences throughout the day for toddlers, preschoolers and kindergarteners enrolled in the Hill Top Day Care Program.

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Washburne, Carleton W., The work of the Committee of Seven on Grade-Placement in Arithmetic, Child Development and Curriculum, Thirty-eighth Yearbook of the National Society for the Study of Education, Part I, Distributed by the University of Chicago Press, 1939.

Further Recommendation:

For an excellent general reference on sequencing early math skills for young children we highly recommend the following:

Resnick, Lauren B., Wang, Margaret C., and Kaplan, Jerome. Task analysis in curriculum design: A hierarchically sequenced introductory mathematics curriculum. Journal of Applied Behavior Analysis, 1973, 6, 679-710.

MATH EXPERIENCES FOR PRESCHOOL CHILDREN:

GAMES AND CUISENAIRE RODS

Elizabeth M. Goetz

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Acquisition of the basic concepts of math such as matching, number and counting, sets and classifying, comparing, measuring, shape, space and parts and whole may be followed by two types of activities. First, the child may subsequently be presented activities that allow for practice and generalization of those acquired concepts. Secondly, the child may be presented activities that extend the use of basic concepts into more advanced learning situations. Games may provide practice and generalization. Cuisenaire rods may provide higher level math experiences appropriate for preschool children.

Games

Generic games that involve basic math skills are lottos, bingos, spinner games, board games, finger plays and songs (e.g., Baratta-Lorton, 1972; Charlesworth and Radeloff, 1978). Often these games involve one-to-one matching (lotto and bingo), numeral recognition and counting (spinner and board games) and set recognition (dice), but games can be devised for practice in classification, comparison, shape, space and parts and whole. The purpose here is not to describe such games but rather to provide guidelines for the selection and use of those games with very young children. Basically, there are seven guidelines:

1. Skills required in a game should have been introduced previously. Games are not to teach skills but to provide practice and generalization of skills already acquired. Games need a fairly fast pace for excitement; learning new skills slows the game and dulls the fun. Furthermore, the range of skills in a game should not be so broad that a child has to wait forever to be able to play the game.
2. Themes or pictures of interest should be incorporated. Star Wars and Superman are currently popular and exciting to children.
3. Playing turns should come quickly. More than three children playing a game makes waiting for one's turn interminable.
4. Success should be assured for each player. Games should be continued until each child successively becomes a winner. One game may have three winners. Games should be designed to be completed within 5-10 minutes.
5. Motor skills required for the game should be possible for each child. Can the child spin the spinner or throw the dice? Are the squares on the board large and distinct enough for the child to move the marker in and out of them? Are the cards a convenient size to handle? Is the entire gameboard accessible? All children should be active in the game; a helper should

not play the game for a child.

6. One child should know the skills well enough to check the correctness of another child's response. This situation promotes child independence in playing a game.
7. In the case of fingerplays or songs, the verse should be a reasonable length to memorize, the words easy to pronounce and the musical key appropriate to a child's voice.

Cuisenaire Rods

Cuisenaire rods, which may be used for higher level math activities, are in keeping with a child's way of thinking. A child's thought is tied to the senses. A child thinks by looking at, feeling and manipulating the environment. The Cuisenaire Rods are visual and tactile embodiments of number; the child actually sees and feels twoness, for example. By manipulating the rods in a specified manner a child may learn the concepts of addition, subtraction, multiplication and division. Many preschool children are able to learn to add and subtract with the rods, expecially using the number concepts of 1 through 5. Those who are not ready for the rods should be taught the preskills to be described later. Ten percent of kindergarten children may learn to multiply with the rods. Fewer than ten percent learn to divide. It is advantageous for the preschool teacher to know how to add, subtract, multiply and divide to be prepared for the gifted child. Therefore, a brief explanation will be given for these four mathematical procedures using the

Cuisenaire rods. Preceding these four procedures will be an explanation of building a staircase with the rods, which is the key to solving all the mathematical problems.

Staircase

The staircase is the vertical placement of the rods side-by-side in one-more order on an orange rod base. The smallest rod (white) is on the left and the largest rod (orange) is on the right. Following are the steps to teaching a child to build a staircase and other related information:

1. a. The bottom brace (orange rod) is placed horizontally.

   b. Build staircase from left-to-right beginning with the smallest rod (white) in a vertical position above the orange base.

   c. After the white rod is placed, tell the child that the next step is one white rod more. A second white rod is placed on top of the first white rod, and the child is to find another rod that is the same height as the two white rods together (the red rod). Continue building from left-to-right always adding one white rod on top of the "CURRENT" rod. This is called the one-more order staircase.

   d. After the staircase is built, count left-to-right touching each rod and saying 1 rod, 2 rods, 3 rods, etc.

e. Then ask the child why this is the 2 rod? Tel the child that it is the 2 rod because it is equal to 2 white rods or 2 one rods. Continue, why is this the 3 rod? Have the child give these explanations back to you. This is very important. The child should not use the staircase to work problems until you are assured that the reasoning behind the staircase is understood.

2. Do not have the child memorize the staircase nor that the white rod is one, the red two, etc. The staircase and the color/number correlation becomes an integral part of the child's knowledge after working with the rods for awhile.
3. Each child works problems with his/her own staircase at the side for a referent in checking the number name of each rod. Eventually the child will discard the staircase voluntarily and work problems without it.
4. Remember when using the rods preferably use the number names only, or initially use a combination of color and number, "Hand me the two red rods. Find the black seven rod."
5. Do not start the worksheets until the child can point to a color and tell you what number it is.
6. Any time the child has a problem with addition or subtraction go back to the white rods, then use the colored rods. Have the child verbalize while working the problem.

Example of Addition with Rods and Worksheet

1. Read while pointing to the problem - 2 + 3 = ____.
2. Place corresponding rods on numerals 2 and 3 (red & green).
3. Place the 2 and 3 rods end-to-end, and find the rod that matches the two together (yellow).
4. Count up the staircase to yellow. It is the fifth rod from left-to-right. The answer is 5.
5. Write 5 in the box.

Example of Subtraction with Rods and Worksheet

1. Read the problem - 5 - 3 = ____.
2. Place corresponding rods on numerals 5 and 3 (yellow and green).
3. Place the green rod (minus rod) on top of the yellow rod.
4. Find the rod that fills the empty space (red).
5. Count up staircase to red rod which is the second rod. The answer is 2.
6. Write 2 in the box.

Example of Multiplication with Rods and Worksheet.

1. Read the problem - 3 X 2 = ____.
2. Place the 3 green rod vertically like a smokestack.
3. Place as many rods horizontally along the green rod as will fit (3 red rods).
4. Discard the green rod smokestack.
5. Place red rods end-to-end like a train.
6. Find the rod that matches the red train (green rod).

7. Count up the staircase from left-to-right stopping at green the sixth rod. The answer is 6.
8. Write 6 in the box.

Example of Division with Rods and Worksheet

1. Read the problem -- 10 ÷ 2 = ____.
2. Place the orange 10 rod in a lying down (horizontal) position.
3. Find out how many red rods will fit on top of the 10 orange rods (5 red rods).
4. Count the number of red rods -- 5. The answer is 5.
5. Write 5 in the box.

Preskills

The preskills need for working with the Cuisenaire rods may be divided into two categories -- the preskills for building the staircase and the preskills for using the rods with math worksheets. A list of each category follows:

Staircase Preskills

1. Left-right tracking.
2. Concept of one-more.
3. Concept of "up and down" (vertical and "lying down" (horizontal).
4. Counting objects one-by-one.
5. Color recognition or matching which helps to locate the correct rod.
6. Fine muscle coordination.
7. Counting from 1-10.

MATH EXPERIENCES THROUGHOUT THE CURRICULUM:

THE DAY CARE PERSPECTIVE

JOAN REIBER

If you will, imagine the following episode taking place in a day care center.

Two three-year old girls are playing in the house area. They attend a full-day program and the housekeeping area is one of six activities that is available to the children during the morning program. Today the girls decide that they would like to "bathe their babies". Their teacher, Kathy, agrees with this idea and asks if they think the dolls that they are playing with are washable. The children decide that their favorite doll should not be washed. Two other children, a boy and a girl, join the activity and under the teacher's direction sort dolls into washable and non-washable groupings. The four children decide that each of them will have a "baby" to wash, and that one will be left over.

The teacher, Kathy, poses a new question: "What can we use for a bath tub?" The children find a nearby container but after comparing each doll with the container size, they discover their two larger dolls do not fit. Kathy finds a larger basin that will be more suitable for the two largest dolls. Kathy and now five children take a pail to the bathroom to obtain warm water. The children take turns filling it. When it is half-full one child offers to carry the pail but it is too

heavy. Each of the children then take a handle and unsuccessfully attempt to carry the water so Kathy helps the children carry the pail back to the classroom. Once the warm water is poured into the two tubs, one bar of soap and one washcloth is secured for each tub. The children take turns washing "babies" for a long period of time.

When the first doll is clean, towels are brought out. Kathy talks about the size of each "baby" and holds up several sizes of towels. After each child compares doll and towel size an appropriate match is made. One non-washable doll has a dirty face and one child elects to wash only a part of the doll but not the whole thing. When the bathing activity is finished, clothes are needed. Children compare dolls and clothes size. After a great deal of experimentation suitable clothes are found for each doll. It is now clean-up time and everything must be returned to its proper place.

For forty minutes these young children were exposed to potential mathematical concepts. The sensitive teacher, Kathy, did not use all of the possible concepts, for she did not want to interrupt the spontaneity of the dramatic play. Nevertheless, with a minimum of adult intrusion and direction the children sorted, matched, ordered, compared and measured. In addition, they were exposed to the concepts of temperature, volume, weight, shape, size and counting.

Incidental or informal learning of mathematical concepts is a vital and essential part of a day-care child's everyday world.

Children who attend all-day programs can have numerous experiences similar to the bathing activity. In many centers the day-care curriculum is improving and today's teachers see the importance of providing some degree of direct mathematical instruction. The wise and experienced teacher knows how to balance the province of free play and minimal adult interference with specific teacher-planned activities. Children and teachers need both during their long day together.

At Hilltop Child Development Center, a campus child care facility at the University of Kansas, the prevailing philosophy of child development is planned freedom. Teachers are expected to be prepared to pre-plan numerous activities for the children. The children, in turn, are allowed free exploration of the materials according to their own interests, desires, and of course, age and skill level. Later, I will describe each classroom, the classroom structure and some of the mathematical concepts that are being introduced to children who attend Hilltop.

First, however, let me tell you about Hilltop. The Center began in 1972 during a period of student discontentment. In February, 1972, many students, mostly women, entered a building and refused to leave. They demanded two things: campus child care and an affirmative action plan. They received both demands, although initially on a limited scale. The University administration secured the space for child care but did not provide any funds. The Student Senate voted to allocate enough money for Hilltop to begin operating, and later assisted with the rent

of the building. Today, Hilltop is a private, federally certified, non-profit corporation. The building that Hilltop occupies is owned by the University, and the Center has grown from three to six classrooms. Today's college students have generally ceased protesting and are concentrating on obtaining degrees that will lead to careers enabling them to survive in our inflationary country.

Like the University student, day-care has also undergone significant changes since 1972. Day-care centers were originally established for the poor and needy. The general public accepted centers for this stratum of the population; after all, these parents had to work and suitable child care was difficult to find. Loving care and nurturance were the key words with little concern for the curriculum or for the qualifications of the teachers. Programs featured some art, music, blocks, housekeeping, and a great deal of free play but little or no direct teaching. The terms "day-care" and "custodial care" were synonymous in earlier years.

Presently, women from all income levels are beginning to need and demand full-day care for their children. Inflation, divorce, fewer children, and the women's movement have all contributed to the growing number of women who are away from the home. Women continue to enter the labor force in increasing numbers. In fact, the number of working mothers with preschoolers increases each day. On most campuses, many mothers are either beginning college or returning to school. They are seeking training to secure better-paying or more rewarding jobs. In significantly increasing numbers, community and campus centers have

become federally certified. This certification enables state and federal governments to provide income-eligible families with child care tuition assistance. Because of these much needed daycare funds for parents, stricter federal and state standards have been developed in an attempts to promote and provide better care for children. These same regulations increase the cost of day care.

Currently, 10-12% of our nation's children under six years of age are enrolled in day care centers. The remainder of the children with working parents stay with relatives, friends, or home day care providers. Current predictions suggest that day care center enrollment will increase by 25% or more over the next ten years. Certainly campus child care is already expanding rapidly. Because of this expansion as well as the greater concentration on early childhood curriculum and on the competencies of teachers, the image of day care is gradually improving. Educators, parents and lay people are beginning to see the necessity of having experienced and trained teachers who will provide a broad array of activities that meet not only social and emotional needs of young children but attend to their intellectual development as well. Well-qualified teachers can still be loving people; but young children deserve much more in addition to loving care.

As far as early childhood curriculum is concerned, the word "preacademics" used to have a cold, institutional, primary-school connotation. It is with relief and great delight that

we can now discuss preacademics and mathematics for the young child without feeling we have betrayed our young children. Anyone who has had experience teaching and observing preschoolers knows that even the very young child is constantly interacting to a world of shapes, sizes, numbers and relationships. Mathematical learnings begin when the child begins to engage in verbal communication. The young toddler wants more milk, asks for the biggest cookie, points at two candles on the birthday cake, stacks pots and pans, wants to help measure and stir ingredients, labels smallest or biggest, and on and on. The challenge to the day care or preschool teacher is to assess in various classroom experiences the mathematical concepts already possessed by children and to expand upon this knowledge.

Recent books have been published that focus on mathematics for the young child. In most cases, the authors have felt that a preacademic skill such as mathematics is a process skill and should not be viewed as an end product. These writers state that the process should be the prime objective in early childhood education. One definition of mathematics is the "recognition and study of patterns that have structures and relationships". When introducing math concepts, teachers are asked to be very sensitive to a child's ability and interest level.

In a day care environment there is ample time for children to engage in mathematical activities in a leisurely fashion. Teachers are urged to coordinate number readiness with all other

aspects of readiness. Concepts can be taught with blocks, during art, lunch, songs, games, stories, language arts activities - actually, during every aspect of the program. According to Cynthia Dawes in her book, Early Math, many preschool or day care programs either ignore mathematics altogether or else push children who appear to be able to count and recognize a few numerals to do the type of mathematics found in kindergarteners or first graders. Dawes believes the primary cause of such programming is the lack of understanding of how to develop mathematical thinking or how to determine the mental ability of the young child. She goes on to say there are three activities in which we must involve the young child and that these are absolutely vital to the understanding of numbers: 1) sorting and classifying into sets, 2) making one-to-one correspondence, and 3) putting things in order. In an article in the magazine, Day Care and Early Education, Sarah Van Camp says the basic math concepts can probably be narrowed down to four simple ideas: 1) balance/equivalence, 2) comparison/measurement/classification/seriation, 3) symbolic representation, and 4) prediction.

All authors of curriculum books for preschoolers agree that the young child needs naturalistic and informal experiences as well as structured learning activities; they agree, too, that concrete items to manipulate are more meaningful than dittos or workbooks. One of the most comprehensive books written for teachers is Charlesworth and Radeloff's book, Experiences in Math for Young Children. Each math concept chapter

includes naturalistic activities, informal activities, and structured activities. I feel that this textbook should be used in every preschool and day care center as well as in all family day care homes. It is filled with a wealth of math ideas for teachers of young children.

I would like to introduce you to the Hilltop programs now and some math activities that have been offered to children this semester. There are six classrooms at our Center, with two programs on each floor. Each room has two paid teachers, one or both of whom is certified. They are assisted by part-time volunteer students. Children are placed into five of the classes according to age. A sixth program has multi-aged children - 2 1/2 to 5 1/2 years of age.

Early in the fall, teachers from each program develop brief screening tests relevant to the ages of the children in their classroom. There are usually four to ten math items on each test in addition to other pertinent items in the social, physical and intellectual areas. Each child's developmental level is assessed either during a regular classroom activity or individually in a more secluded area. While many teachers prepare lesson plans which include the presentation of math concepts, the primary focus is on informal math experiences prevalent in a preschooler's day.

Toddlers:

Our youngest age group consists of ten toddlers, aged 1 1/2 to 2 1/2 years of age. Their classroom is located on the bottom

floor. A front room and a back room, joined by a very small bathroom, comprise the toddler home. Even the narrow hall is part of the classroom. On the walls are plastic covered pictures for the children to view and touch, as well as a masonite board covered with various textures for "feeling". A little more than a year ago, the toddler rooms, used only for napping in cribs, were dull and plain. Today, thanks to very creative teachers, they are vibrant with color, pictures, suitable materials and equipment.

While the primary focus of any toddler program is on diapering, feeding, comforting, moving, and touching, the two teachers also plan specific daily activities. Many mathematical concepts are taught outdoors. Children may discuss and demonstrate understanding concepts such as "big" and "little" by comparing the sizes of dogs, trees, or people that they see on their walks. They may also label colors or shapes.

Teachers often bring naturalistic materials to demonstrate concepts. For instance, one day a teacher brought acorns and walnuts to school. She talked about size and texture and those children who wished to do so sorted the nuts into two categories. Of course, most of the time was spent touching and holding the nuts.

There are five mathematical items on the toddler screening test that concentrate on size and shape discrimination. The items include correctly sorting three shapes, stacking nesting blocks (which come in a series of sizes); stacking circles by size on a spindle; putting together a circle puzzle which includes

round shapes that are different sizes; and putting together a formboard with different shapes. The inset cylinder, a shape puzzle and a shape inset board are some of the materials which help to foster these skills.

2 1/2 Years:

Thirteen full-time children are enrolled in the 2 1/2 year-old room, staffed by a male and a female teacher. Their program is housed in three rooms which indludes a kitchen for eating meals as well as for art and water activities. Additionally, there is a front room for block play, playing house or climbing. A four-foot high climber was made by a staff member. In a third room there are three tables and a long shelf filled with boxes that contain materials. There are numerous materials for sorting and shape discrimination as well as for counting. Children select their own table activities from a large array of choices. For instance, one child may enjoy putting pegs into numeral cards. While numeral recognition has little meaning for very young children, they enjoy putting objects into appropriate holes and rote counting. The opportunity for learning more advanced mathematical skills is always available for the child who is interested and ready. Art activities such as a mural or stick people and their homes enables 2 1/2 year olds to look closely at parts that form a whole. The screening test items for this age group includes matching shapes, matching colors, rote counting 1-5, discriminating items that are large or small, and naming circles, squares and triangles. It will take the full year for some

children to understand the concept of circle, while others will comprehend squares and triangles in a period of months.

3 years:

On the south side of the building, middle floor, is a large classroom for the three-year-olds. The eighteen children in this program stay a full-day. As in all six of the classrooms, their room is divided into small activity centers, with ample space available for large group time. One activity that was planned for "circle" time was a treasure hunt where children searched for numeral cards depicting the symbols "3" and "4". Prior to the "hunt" the children counted concrete objects and sang songs that included these quantity concepts.

Teachers in this room plan many table activities t[illegible]nce the 3-year-olds' mathematical knowledge. Three mathemat[illegible] items included on the screening test are rote counting to [illegible] counting ten objects, and recognizing numerals to 10. Putti[illegible] together shape puzzles, putting beads on numeral spindles, and pasting shapes on a collage are examples of popular activities for this age group. Other favorite math activities include measuring ingredients for a cooking exercise, counting with small teddy bear figures, and matching lotto cards. Children need numerous opportunities to discriminate between likenesses and differences before they are ready for more formal and symbolic math programs. One day one of the teachers brought to school a teacher-made train made out of construction paper and asked the children to arrange the box cars in correct numerical order.

While some of the children could accomplish this task with minimal teacher direction, many needed a great deal of encouragement and direction, and a few were not ready to do more than move the box cars about or talk about the train itself.

Multi-Age:

On this same floor is the multi-age room, an extended day preschool program for children 2 1/2 - 5 1/2 years of age. Children attend from 8:00 - 12:00 in the morning, and from 1:00 - 5:00 in the afternoon, with optional lunch for both sessions. The area which houses this program formerly contained small offices. The classroom is large with partitioned areas for the house and art areas. In the open area there is a large round rug that is used for circle time and for other floor activities. One favorite activity on this rug has been the game called "fishing". Pond lines are delineated by tape on the rug and each fish (made by a teacher) has a numeral printed on it plus corresponding lines or dots. When a fish is "caught" with a pole the child names the numeral and counts the number of objects. As in all classrooms, circle time covers numerous songs and finger plays involving numbers.

Because the children in this program vary greatly in age and skill ability, a variety of table activities are offered to the children. As in the 2 1/2, 3, and 4 year-old programs, children select their own activities from a wide array of activities that have been planned by the teachers. The easel, blocks and house areas are available every day and often are unplanned by teachers.

Some of the table pre-math activities that have been offered this semester include tracing insets, size sequencing with a variety of materials, building cube structures from patterns, and placing correct parquetry blocks on cards. In addition to using commercial materials, teachers also make their own. Teachers have made counting and sorting baskets out of green plastic vegetable containers covered with colored paper. Children sort teddy bear counters first by color, later by placing bears in the corresponding basket containing the correct numeral.

Because of the wide age range, the mathematical items on the multi-age screening test covers 19 items. They range from completing a shape formboard and rote counting to putting numerals 1-10 in proper sequences and counting 1-100.

4 Years:

The location of the full-day 4-year-old program is the top floor, north side. There are 20 children, two full-time teachers (male and female) and a part-time practicum student. As in all programs, at least one teacher is certified at the appropriate level. After breakfast and toileting, the day begins in circle time. The male teacher enjoys large group a great deal and his children have been known to participate for over 30 minutes. Songs dealing with numbers such as five little ducks or frogs are loved by most of the children. There are two preacademic areas - the math center and the language arts area.

Optional teacher-directed math activities are available almost every day. Activities might include using cubes to learn

the concepts "middle, first, second and last"; or correctly seriating objects from largest to smallest. One favorite math material is the geoboard. The teachers made wooden geoboards and geoboard pattern sheets. The pattern sheets and the children's progress records are kept in a notebook. Because of this recording system the teachers know which cards have been successfully completed by each child.

Unifix cubes and accessories are also enjoyed by the children. Children often place one-hundred cubes in a straight container and later remove these cubes and put them onto a board which contains one-hundred spaces. They are usually surprised to find they fit perfectly in both containers. Other favorite math materials are cuisenaire rods and attribute blocks. In addition to recording the children's progress on the geoboards and the unifix cubes, teachers check children to see how far they can rote count and count objects. Teachers check to see whether children can name a square, triangle, and circle, and label numerals 0-10.

Kindergarten:

The kindergarten room has 16 children who attend all day and 12 who come half-days for a total of 22 children at one time. Their two teachers are certified in elementary education. One teacher is responsible for the math program, the other the reading program. Their large room is divided into six activity centers. During the morning program children attend four centers. One area is the math center. One group of children may work on a

math sheet from a work book, another group on seriating largest to smallest. Besides working in math work books or with dittos, the children also use teacher-made games and commercial items. Children enjoy learning numerals while playing the popular game of bingo. The math teacher made a shape notebook for the children to use with the attribute blocks which are a commercial product. Many other concrete materials are used in this program.

Studying the calendar for specific days and dates as well as checking the birthday calendar are common occurrences. Understanding coins is another popular activity. Basically, the children in our kindergarten class are exposed to the same mathematical concepts that are presented in public school. While our teacher-child ratio of 1:11 is more conducive to individualized curriculum, it is often difficult to meet both the needs of children who have been with us for a full day and need a relaxing unstructured afternoon, and the needs of children who attend only in the afternoon and require more exposure to teacher-directed math activities. With the assistance of student volunteers some tutoring is possible for some of the children with special needs; but generally, afternoons involve art, music, science, outdoor play, and one group involving math or language arts.

Teachers in all sic programs strive to balance incidental and unstructured math learning with more structured teacher-directed activities. Both are necessary in day care today.

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